BAYOU NEZPIQUE TMDL FOR NUTRIENTS

SUBSEGMENT 050301

US EPA Region 6

Final

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources discharging to the waterbody. A TMDL has been developed for nutrients for Bayou Nezpique.

Bayou Nezpique, Subsegment 050301, was listed on the October 28, 1999 Court Ordered §303(d) List as not fully supporting the water quality standard for propagation of fish and wildlife and was ranked as a high priority for TMDL development. In the State of Louisiana Surface Water Quality Standards, the general criterion for nutrients states "The naturally occurring range of nitrogen-phosphorus ratios shall be maintained…. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters." In addition, LDEQ issued a declaratory ruling on April 29, 1996, concerning this language and stated, "That DO directly correlates with overall nutrient impact is a well-established biological and ecological principle. Thus, when the LDEQ maintains and protects DO, the LDEQ is in effect also limiting and controlling nutrient concentrations and impacts." In this TMDL, the nutrient loading required to maintain dissolved oxygen standards will be the nutrient TMDL. Based on the recently completed Use Attainability Analysis (UAA) for the Mermentau River Basin, the applicable DO criteria for this subsegment are 3.0 mg/L for the summer months March through November and 5.0 mg/L for the winter months December through February.

EPA has identified nutrient ratios using twenty years of historical values in the State of Louisiana's database, and ranges of ratios found in scientific literature indicating nitrogen or phosphorus limitation. Literature generally indicates that where the nitrogen to phosphorus ratio is less than ten, a water body system is considered to be nitrogen limited. Review of historical State data for Bayou Nezpique indicates that 206 out of 226 assessed sampling events displayed nitrogen limitation ratios and that phosphorus was not in excess (Appendix A). Since 91% of the sampling events confirmed nitrogen limiting conditions, it has been determined that a nitrogen TMDL for Bayou Boeuf is warranted. A TMDL for phosphorus is not necessary because controls on nitrogen will maintain naturally occurring nitrogen-phosphorus ratios. Therefore, the nitrogen loading required to maintain the dissolved oxygen standard will constitute the nutrient TMDL.

This nutrient TMDL includes 14 point source dischargers, wasteload allocations, load allocations and margins of safety. As presented in LDEQ (1999), the summer season DO criterion of 3.0 mg/L can be maintained with an 85% reduction of all manmade nonpoint sources and implementation of the wasteload allocations (WLAs) for the point source dischargers as presented in Table 2 of this report. For the winter season, the DO criterion of 5.0 mg/L can be maintained with a 90% reduction from all manmade nonpoint sources and implementation of the WLAs for the point source dischargers as presented in Table 2.

1. Introduction

Bayou Nezpique, Subsegment 050301, was listed on the October 28, 1999 Court Ordered §303(d) list as not fully supporting the water quality standard for the propagation of fish and wildlife and was ranked as a high priority for TMDL development. TMDLs for nutrients were developed in accordance with the requirements of Section 303 of the federal Clean Water Act. The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant; the TMDL also establishes the load reduction that is necessary to meet the standard in a waterbody. The TMDL consists of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The wasteload allocation is the load allocated to point sources of the pollutant of concern, and the load allocation is the load allocated to nonpoint sources. The margin of safety is a percentage of the TMDL that accounts for the uncertainty associated with the model assumptions and data inadequacies.

2. Study Area Description

Water quality segment 0503 is part of the Mermentau River Basin. The Basin encompasses the prairie region of the state and a section of the coastal zone. The drainage area for the Basin, excluding the gulf water segment, is 3,710 square miles. The segment is located in south central Louisiana in the parishes of Evangeline, Acadia, Allen, and Jefferson Davis and has a drainage area of 611.2 square miles. The segment is long and narrow and spans the land uses characteristic of the entire basin. The northern part of the segment is a flatwoods area. The midsection is prairie, characterized by large expanses of flat grassland and scattered areas of oak trees and other mixed hardwoods, and the southern part is marshland. The flatwoods and the prairie are generally considered upland areas while the marshland is considered a coastal area. The slope of the land is generally north to south. Because of its relatively low relief, especially in the prairie and marsh areas, the region is characterized by poor drainage and annual backwater flooding of agricultural lands. The land use in the watershed is summarized in Table 1. See LDEQ (1999) for additional discussion of the study area.

Table 1. Land Uses in Segment 0503

LAND USE TYPE	NUMBER OF ACRES	% OF TOTAL AREA
Urban	9,979	1.63
Extractive	123	0.02
Agricultural	318,357	52.07
Forest Land	169,531	27.73
Water	3,312	0.54
Wetland	106,581	17.43
Barren Land	3,282	0.54
Other	224	0.04
TOTAL AREA	611,389	100

2.1 Bayou Nezpique, Subsegment 050301

Bayou Nezpique is located in south central Louisiana and its watershed includes the following tributaries: Beaver Creek, Boggy Bayou, East and West Forks of Bayou Nezpique, Manwell Gully, Grand Louis Bayou, Castor Creek, Bayou Blue, Roger's Gully, Bayou Duralde, Jennings STP Canal, and several unnamed tributaries. The watershed is 611.2 square miles in area. Bayou Nezpique is in the Mermentau River Basin and is included in water quality subsegments 050301, 050302, 050303, and 050304.

2.2 Water Quality Standards

The designated uses for Bayou Nezpique include the propagation of fish and wildlife. In the State of Louisiana Surface Water Quality Standards, the general criterion for nutrients states "The naturally occurring range of nitrogen-phosphorus ratios shall be maintained. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters." In addition, LDEQ issued a declaratory ruling on April 29, 1996, concerning this language and stated, "That DO directly correlates with overall nutrient impact is a well-established biological and ecological principle. Thus, when the LDEQ maintains and protects DO, the LDEQ is in effect also limiting and controlling nutrient concentrations and impacts." DO serves as the indicator for the water quality criteria and for assessment of use support. In this TMDL, the nutrient loading required to maintain the dissolved oxygen standard is the nutrient TMDL.

EPA has identified nutrient ratios using historical values in the State of Louisiana's database, and ranges of ratios found in scientific literature indicating nitrogen or phosphorus limitation. Based upon the literature, nitrogen to phosphorus ratios of less than ten are generally indicative of a nitrogen limited water body system (Wetzel 1975, Day 1989, Allan 1995). The twenty-year average for nitrogen to phosphorus ratio (March 1978 through May 1998) is 6.84 (Appendix A). Review of historical State data for Bayou Nezpique also indicates that 206 out of 226 assessed sampling events displayed nitrogen limitation ratios and that phosphorus was not in excess (Appendix A). Since 91% of the sampling events confirmed nitrogen-limiting conditions, it is determined that a nitrogen TMDL for Bayou Boeuf is warranted. A TMDL for phosphorus is not necessary because controls on nitrogen will maintain naturally occurring nitrogen-phosphorus ratios. Therefore, the nitrogen loading required to maintain the dissolved oxygen standard will constitute the nutrient TMDL.

The applicable dissolved oxygen criteria are as follows:

Season	Temperature (^{o}C)	DO(mg/L)
Summer (March - November)	32	3.0
Winter (December - February)	32	5.0

Table 2. Point Source Waste Load Allocations

Dischargers to Bayou Nezpique									
Facility	Permit #	Receiving Water	Discharge Flow MGD	Summer CBOD5/ NH3-N mg/l	Winter CBOD5/ NH3-N mg/l	Summer CBOD5 WLA lbs/day	Summer NH3-N WLA lbs/day	Winter CBOD5 WLA lbs/day	Winter NH3-N WLA lbs/day
City of Oakdale, WWTP	LA0033430	Bayou Nezpique	1.46	10/10	10/10	121.76	121.76	121.76	121.76
Village of Pine Prairie, STP	LA0079057	Bayou Nezpique	0.1	10/10	10/10	8.34	8.34	8.34	8.34
Reddell, STP	LA0109452	Bayou Nezpique	0.068	5/5	10/5	2.84	2.84	5.68	2.84
Evangeline Sewer Co. INC.	LAG560049	Bayou Nezpique	0.0364	10/5	20/10	3.04	1.52	6.08	3.04
Town of Mamou, WWTP	LA0020125	Bayou Nezpique	0.6	10/2	10/2	50.05	10.01	50.05	10.01
Town of Oberlin, STP	LA0020087	Bayou Nezpique	0.363	5/2	10/10	15.125	6.05	30.27	30.27
Town of Elton, WWTP	LA0061719	Bayou Nezpique	0.193	5/2	10/10	8.05	3.22	3.22	16.1
Basile, WWTP	LA0044865	Bayou Nezpique	0.5	5/2	10/10	20.85	8.34	41.7	41.7
City of Jennings, STP	LA0041769	Bayou Nezpique	2.5	5/2	5/5	104.25	41.7	104.25	104.25
Academy Trailer Park	LAG540033	Bayou Nezpique	0.0132	20/15	20/15	1.65	1.65	1.65	1.65
Evangeline PH Police Jury	LAG540293	Bayou Nezpique	0.01825	20/15	20/15	2.28	2.28	2.28	2.28
Jefferson Davis PH School Board	LAG540397	Bayou Nezpique	0.011	20/15	20/15	1.38	1.38	1.38	1.38

La Dept. of Transportation & Dev.	LAG560109	Bayou Nezpique	0.025	20/15	20/15	3.13	3.13	3.13	3.13
Rice Bran & Oil, LLC.	LA0098477	Bayou Nezpique	0.0014	20/15	20/15	0.18	0.18	0.18	0.18
		TOTAL				342.925	212.64	379.97	263.77
		TOTAL (NH3-N * 4.3=UNBOD)					914.25		1134.21
		TOTAL (CBOD5 * 2.3=UCBOD)				788.73		873.93	

Note: For the last five dischargers listed above, CBOD5 and NH3-N concentrations were assumed as 20 mg/l and 15 mg/l, respectively.
Note: NH3-N represents is representative of total nitrogen.

2.3 Identification of Sources

The sources identified in the *1998 Louisiana Water Quality Inventory* as affecting the water quality of Bayou Nezpique are minor municipal point sources, minor industrial point sources, agriculture (irrigated and non-irrigated crop production), and silviculture sources (LDEQ 1998). Suspected sources identified in the State's 1993 Nonpoint Source §319 Report also include aquaculture, urban runoff, and waste storage (LDEQ 1993).

2.3.1 Point Sources

There are 14 permitted facilities with known flow information discharging sanitary wastewater into Bayou Nezpique and its tributaries (see Table 2). Nutrient contribution from the point source dischargers will be controlled through NPDES permit limits for NH_3-N, which is representative of total nitrogen.

2.3.2 Nonpoint Sources

The predominant land uses along Bayou Nezpique are agriculture and forestry, both of which can contribute to nutrient loads through runoff. There are also numerous rural residences where domesticated animals may be found. These rural residences may also contribute to the nutrient load if they have septic tanks or septic fields for their wastewater treatment.

3. TMDL Load Calculations

LDEQ submitted a DO model for Bayou Nezpique subsegment 050301 in July 1999 (LDEQ 1999). The model was reviewed and approved by EPA. This model was used to address the nutrient listing for this segment. Table 8 of the DO TMDL modeling report presents cumulative WLAs, LAs, and MOS for nine point source dischargers (LDEQ 1999). For the additional five minor dischargers, WLAs were calculated based on $CBOD_5$ and NH_3-N concentrations of 20 mg/L and 15mg/L respectively. For these 5 minor dischargers, the $CBOD_5$ and NH_3-N concentrations were selected based on the existing treatment processes currently being utilized. However, if a facility's existing permit contains more stringent limits for $CBOD_5$ and NH_3-N, those stringent limits should be used. Tables 2 and 3 present the WLAs, LAs, and MOS for this nutrient TMDL.

3.1 Loading Capacity and TMDL Formulation

According to LDEQ (1999), input data for the calibration model was developed from the LDEQ Reference Stream Study, data collected during the 1985 intensive survey, data collected by LDEQ and USGS at several ambient monitoring stations in the watershed, DMRs, permits and permit applications for each of the point source dischargers, USGS drainage area and low flow publications, previous modeling studies conducted by LDEQ in the area, and data garnered from several previous LDEQ studies on non point source loadings. A satisfactory calibration was achieved for the main stem and most of the tributaries modeled. In those cases where the calibration was not as accurate (primarily due to extremely limited data), the difference was in

the conservative direction. For the projection models, data was taken from the current municipal discharge permits, current applications, and ambient temperature records.

Modeling was limited to low flow scenarios for both the calibration and the projections since the constituent of concern was dissolved oxygen and the available data was limited to low flow conditions. The model used was QUAL-TX, a modified version of the QUAL-II water quality modeling system. QUAL-TX was selected since it offers the ability to model branched systems and has been used successfully in Louisiana in the past. See LDEQ (1999) for additional discussion of the study area.

3.2 Load Allocations

Seasonal load allocations are presented in Table 3. See LDEQ (1999) for a detailed discussion of load allocation. The load allocation in Table 3 is calculated using the sum of natural nonpoint source LAs and manmade nonpoint source LAs presented in Table 8 of LDEQ (1999) minus WLAs for five minor discharges (Permit #'s LAG540033, LAG540293, LAG540397, LAG560109 and LA0098477) presented in Table 2 of this report.

As presented in LDEQ (1999), the summer season DO criterion of 3.0 mg/L can be maintained with an 85% reduction of all manmade nonpoint sources. For the winter season, the DO criterion of 5.0 mg/L can be maintained with a 90% reduction from all manmade nonpoint sources.

Table 3. Total Maximum Daily Loads

ALLOCATION	SUMMER (March – November) lbs/day UBOD=UCBOD+UNBOD	WINTER (December – February) lbs/day UBOD=UCBOD+UNBOD
Point Source WLA	1702.98	2008.14
Margin of Safety	3750.14	3199.41
Load Allocation	13291.00	10394.40
TMDL	18744.12	15601.95

3.3 Wasteload Allocations

Seasonal wasteload allocations for individual point source dischargers are presented in Table 2. The total cumulative WLAs for summer and winter are presented in Table 3.

3.4 Seasonal Variation

Critical conditions for dissolved oxygen in Louisiana have been determined to be when there is negligible nonpoint run-off and low stream flow combined with high stream temperature. In addition, the models account for loadings that occur at higher flows by modeling sediment oxygen demand. Oxygen demanding pollutants that enter the stream during higher flows settle

to the bottom and then exert the greatest oxygen demand during the high temperature seasons. Additionally, this TMDL looked at the winter and summer seasons by varying temperature.

3.5 Margin of Safety

The margin of safety (MOS) presented in Table 3 was calculated as the sum of point source reserve MOS, natural nonpoint source reserve MOS and manmade nonpoint source reserve MOS values presented in Table 8 of LDEQ (1999). The MOS accounts for any lack of knowledge or uncertainty concerning the relationship between load allocations and water quality. According to LDEQ (1999), the highest temperatures occur in July-August, the lowest stream flows occur in October-November, and the maximum point source discharge occurs following a significant rainfall, i.e. high-flow conditions. The combination of these conditions, in addition to other conservative assumptions regarding rates and loadings, yields an implied MOS which is estimated to be in excess of 10%. Over and above this implied MOS, LDEQ regularly uses an explicit MOS of 20% for both point and nonpoint loads. The total MOS is estimated to exceed 30% for the Bayou Nezpique TMDL.

4. Other Relevant Information

Although not required by this TMDL, LDEQ utilizes funds under Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to operate an established program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters. This information is also utilized in establishing priorities for the LDEQ nonpoint source program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following establishment of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list. The sampling schedule for the first five-year cycle is shown below. The Mermentau River Basin will be sampled again in 2003.

1998 – Mermentau and Vermilion-Teche River Basins
1999 - Calcasieu and Ouachita River Basins
2000 – Barataria and Terrebonne Basins
2001 – Lake Pontchartrain Basin and Pearl River Basin
2002 – Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.)

In addition to ambient water quality sampling in the priority basins, the LDEQ has increased compliance monitoring in those basins, following the same schedule. Approximately 1,000 to 1,100 permitted facilities in the priority basins were targeted for inspections. The goal set by LDEQ was to inspect all of those facilities on the list and to sample 1/3 of the minors and 1/3 of the majors. During 1998, 476 compliance evaluation inspections and 165 compliance sampling inspections were conducted throughout the Mermentau and Vermilion-Teche River Basins.

5. Public Participation

When EPA establishes a TMDL, 40 C.F.R. § 130.7(d)(2) requires EPA to publicly notice and seek comment concerning the TMDL. Pursuant to an October 1, 1999, Court Order, EPA prepared this TMDL. After submission of this TMDL to the Court, EPA commenced preparation of a notice seeking comments, information and data from the general and affected public. Comments and additional information were submitted during the public comment period and this Court Ordered TMDL was revised accordingly. EPA has transmitted this revised TMDL to the Court, and to the Louisiana Department of Environmental Quality (LDEQ) for incorporation into LDEQ's current water quality management plan.

REFERENCES

Allan, J. D. 1995. *Stream Ecology*: Structure and Function of Running Waters. Chapman and Hall, London.

Day, J.W. Jr., et al. 1989. *Estuarine Ecology.* John Wiley and Sons, New York.

LDEQ. 1993. *State of Louisiana Water Quality Management Plan, Volume 6, Part A: Nonpoint Source Pollution Assessment Report.* Louisiana Department of Environmental Quality, Office of Water Resources, Baton Rouge.

LDEQ. 1998. *State of Louisiana Water Quality Management Plan, Volume 5, Part B: Water Quality Inventory*. Louisiana Department of Environmental Quality, Office of Water Resources, Baton Rouge.

LDEQ. 1999. Bayou Nezpique Watershed TMDL For Dissolved Oxygen Including WLAS For Nine Treatment Facilities, Subsegments 050301, 050302, 050303, and 050304, Surveyed September 1985. Louisiana Department of Environmental Quality, Office of Water Resources, Baton Rouge.

LDEQ Data Web Site. www.deq.state.la.us/surveillance/wqdata/wqnsites.stm

Wetzel, R. G. 1975. *Limnology.* W.B. Saunders Co., New York.

APPENDIX A

(Source: http://www.deq.state.la.us/surveillance/wqdata/0005wqng.txt)

050301 Bayou Nezpique North of Basile, LA

Date	NO2+NO3	TKN	TP	TOC	TN	N:P	N:P avg	Time	Depth
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			m
5/12/98	0.34	2.30	0.30	9.8	2.64	8.80	6.84	930	0.3
4/14/98	0.48	4.60	0.67	15.5	5.08	7.58		922	0.5
3/10/98	0.08	0.99	0.15	12.3	1.07	7.13		923	1.0
2/10/98	0.16	1.25	0.15	7.6	1.41	9.40		1020	0.0
1/13/98	0.03	0.97	0.09	10.2	1.00	11.11		945	1.0
12/9/97	0.20	1.20	0.20	11.8	1.40	7.00		940	1.0
11/18/97	0.32	0.98	0.23	10.6	1.30	5.65		1025	1.0
10/14/97	0.07	0.99	0.24	9.6	1.06	4.42		935	0.3
9/9/97	0.10	1.12	0.27	7.9	1.22	4.52		1045	1.0
8/12/97	0.28	1.38	0.25	10.8	1.66	6.64		900	1.0
7/15/97	0.56	1.96	0.43	17.1	2.52	5.86		1000	1.0
6/10/97	0.53	1.58	0.25	10.1	2.11	8.44		900	1.0
5/13/97	0.55	2.94	0.40	10.4	3.49	8.73		1050	1.0
4/15/97	0.24	3.36	0.33	9.5	3.60	10.91		1015	1.0
3/11/97	0.26	1.86	0.28	9.5	2.12	7.57		1040	1.0
2/18/97	0.02	0.62	0.12	11.4	0.64	5.33		1035	1.0
1/7/97	0.08	1.58	0.20	18.3	1.66	8.30		950	1.0
12/10/96	0.19	0.73	0.44	11.9	0.92	2.09		1050	1.0
11/19/96	0.02	1.31	0.13	14.2	1.33	10.23		1000	1.0
10/15/96	0.26	0.87	0.23	9.1	1.13	4.91		1030	0.3
9/10/96	0.27	0.69	0.23	13.1	0.96	4.17		1020	0.3
8/13/96	0.24	1.15	0.21	9.7	1.39	6.62		940	1.0
7/9/96	0.39	2.07	0.19	23.5	2.46	12.95		1017	0.3
6/11/96	0.59	1.04	0.19	12.9	1.63	8.58		1000	1.0
5/14/96	1.17	5.66	1.12	15.3	6.83	6.10		950	1.0
4/9/96	0.92	4.26	0.50	13.4	5.18	10.36		1050	1.0
3/12/96	0.44	0.42	0.13	9.9	0.86	6.62		1000	0.3
2/13/96	0.30	0.55	0.12	10.8	0.85	7.08		1020	0.3
1/9/96	0.34	0.56	0.14	10.2	0.90	6.43		1040	1.0
12/12/95	0.57	1.45	0.17	13.4	2.02	11.88		1050	1.0
11/14/95	0.26	0.57	0.15	10.2	0.83	5.53		1020	1.0
10/10/95	0.32	0.71	0.18	9.8	1.03	5.72		1100	1.0
9/12/95	0.01	1.18	0.12	4.9	1.19	9.92		1000	1.0
8/15/95	0.18	0.56	0.07	6.8	0.74	10.57		1030	1.0
7/11/95	0.40	1.48	0.09	7.4	1.88	20.89		1025	1.0
6/13/95	0.72	1.13	0.24	8.6	1.85	7.71		1000	1.0
5/9/95	0.38	1.95	0.60	8.8	2.33	3.88		1045	1.0
4/4/95	0.22	1.74	0.36	10.1	1.96	5.44		1130	1.0

Date	NO2+NO3	TKN	TP	TOC	TN	N:P	N:P avg	Time	Depth
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			m
3/14/95	0.08	3.75	0.16	13.9	3.83	23.94		1020	1.0
2/14/95	0.42	1.27	0.23	9.8	1.69	7.35		1050	1.0
1/10/95	0.34	1.19	0.23	9.7	1.53	6.65		1005	1.0
12/13/94	0.13	1.20	0.18	11.9	1.33	7.39		1000	1.0
11/15/94	0.23	0.49	0.16	9.5	0.72	4.50		1035	1.0
10/11/94	0.09	0.65	0.14	7.6	0.74	5.29		1015	0.3
9/12/94	0.26	0.79	0.22	10.8	1.05	4.77		1100	1.0
8/9/94	0.35	1.04	0.36	7.6	1.39	3.86		940	1.0
7/12/94	0.05	0.93	0.15	10.4	0.98	6.53		1000	1.0
6/14/94	0.47	1.11	0.18	11.2	1.58	8.78		1000	1.0
4/12/94	0.38	1.84	0.34	11.7	2.22	6.53		1115	1.0
3/15/94	0.15	1.78	0.31	10.3	1.93	6.23		1030	1.0
2/8/94	0.02	1.10	0.07	12.6	1.12	16.00		1010	1.0
1/11/94	0.46	1.47	0.36	9.5	1.93	5.36		1020	1.0
12/14/93	0.09	1.15	0.23	10.9	1.24	5.39		1015	1.0
11/16/93	0.18	1.01	0.24	15.6	1.19	4.96		1045	1.0
10/12/93	0.18	0.81	0.21	9.4	0.99	4.71		1030	0.3
9/14/93	0.03	0.76	0.16	8.8	0.79	4.94		935	0.3
8/10/93	0.20	1.08	0.21	9.4	1.28	6.10		1030	1.0
7/13/93	0.70	1.43	0.29	10.4	2.13	7.34		1000	1.0
6/15/93	0.29	4.80	0.18	11.5	5.09	28.28		1130	0.3
5/11/93	0.66	1.45	0.23	14.7	2.11	9.17		1030	1.0
4/13/93	0.02	0.78	0.10	12.5	0.80	8.00		1140	1.0
3/9/93	0.17	0.68	0.61	12.0	0.85	1.39		1026	1.0
2/8/93	0.24	1.12	0.24	11.6	1.36	5.67		1100	1.0
1/12/93	0.11	1.30	0.16	15.3	1.41	8.81		1000	1.0
12/15/92	0.11	1.22	0.23	16.4	1.33	5.78		1040	1.0
11/17/92	0.27	1.10	0.33	12.7	1.37	4.15		1140	1.0
10/13/92	0.15	0.79	0.20	9.4	0.94	4.70		930	0.3
9/15/92	0.46	1.05	0.33	12.0	1.51	4.58		1120	0.3
8/11/92	0.29	4.52	0.18	7.9	4.81	26.72		1040	0.3
7/13/92	0.65	1.15	0.25	8.9	1.80	7.20		1037	1.0
6/16/92	0.63	1.48	0.34	10.9	2.11	6.21		1040	1.0
5/12/92	0.85	1.75	0.36	13.7	2.60	7.22		1015	1.0
4/7/92	0.57	2.78	0.55	18.3	3.35	6.09		915	1.0
3/10/92	0.11	0.63	0.09	7.6	0.74	8.22		1000	1.0
2/11/92	0.07	0.86	0.14	8.7	0.93	6.64		1000	1.0
1/7/92	0.38	1.16	0.23	11.1	1.54	6.70		1110	0.3
12/10/91	0.16	1.43	0.28	15.8	1.59	5.68		1030	1.0
11/19/91	0.26	1.44	0.44	14.1	1.70	3.86		1008	1.0
10/15/91	0.03	0.87	0.24	9.3	0.90	3.75		1050	0.3
9/9/91	0.16	1.32	0.21	14.2	1.48	7.05		1035	1.0
8/13/91	0.35	0.85	0.22	10.2	1.20	5.45		939	1.0

Date	NO2+NO3	TKN	TP	TOC	TN	N:P	N:P avg	Time	Depth
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			m
7/16/91	0.24	1.05	0.20	10.2	1.29	6.45		1025	1.0
6/11/91	0.51	1.44	0.22	11.2	1.95	8.86		930	1.0
5/14/91	0.07	0.77	0.11	11.3	0.84	7.64		950	1.0
4/16/91	0.15	1.08	0.14	14.7	1.23	8.79		950	1.0
3/12/91	0.40	1.19	0.27	12.8	1.59	5.89		1000	1.0
2/5/91	0.25	1.92	0.36	11.3	2.17	6.03		1050	1.0
1/14/91	0.07	0.81	0.09	12.3	0.88	9.78		1125	1.0
12/10/90	0.35	1.15	0.42	13.4	1.50	3.57		1050	1.0
11/13/90	0.26	1.09	0.34	10.7	1.35	3.97		1030	1.0
10/16/90	0.35	1.27	0.61	11.8	1.62	2.66		1010	1.0
9/11/90	0.06	1.18	0.53	10.3	1.24	2.34		1040	1.0
8/14/90	0.46	1.04	0.31	7.9	1.50	4.84		925	1.0
7/10/90	0.28	0.99	0.28	10.3	1.27	4.54		932	1.0
6/12/90	0.84	1.47	0.44	11.1	2.31	5.25		900	1.0
5/15/90	1.08	1.46	0.31	8.2	2.54	8.19		930	1.0
4/10/90	0.89	4.56	0.91	27.4	5.45	5.99		950	1.0
3/13/90	0.35	0.85	0.20	11.9	1.20	6.00		1030	1.0
2/13/90	0.06	1.25	0.17	11.8	1.31	7.71		1007	1.0
1/9/90	0.21	0.98	0.13	13.9	1.19	9.15		1000	1.0
12/11/89	0.85	0.74	0.26	13.5	1.59	6.12		927	1.0
11/14/89	0.52	1.42	0.39	11.9	1.94	4.97		1030	1.0
10/10/89	0.02	0.85	0.17	8.9	0.87	5.12		945	1.0
9/12/89	0.55	1.05	0.35	9.2	1.60	4.57		1018	1.0
8/15/89	0.23	1.29	0.22	8.1	1.52	6.91		900	1.0
7/11/89	0.10	0.89	0.11	9.8	0.99	9.00		945	1.0
6/13/89	0.42	1.16	0.20	10.3	1.58	7.90		1145	1.0
5/9/89	0.44	1.91	0.28	15.1	2.35	8.39		935	1.0
4/11/89	0.79		1.78	45.3				1025	1.0
3/14/89	0.44	1.32	0.27	11.9	1.76	6.52		1010	1.0
2/14/89	0.43	1.27	0.31	10.3	1.70	5.48		950	1.0
1/10/89	0.12	1.18	0.21	14.8	1.30	6.19		1220	1.0
12/12/88	0.50	1.33	0.40	14.9	1.83	4.58		1145	1.0
11/15/88	0.30	0.96	0.31	10.9	1.26	4.06		950	1.0
10/11/88	0.46	1.64	0.49	12.1	2.10	4.29		950	1.0
9/13/88	0.38	1.15	0.37	14.0	1.53	4.14		1000	1.0
8/9/88	0.49	0.97	0.29	7.0	1.46	5.03		920	1.0
7/12/88	0.25	1.07	0.25	8.2	1.32	5.28		850	1.0
6/13/88	0.41	1.70	0.29	12.3	2.11	7.28		950	1.0
5/10/88	0.67	2.67	0.44	18.4	3.34	7.59		930	1.0
4/12/88	0.37	1.92	0.39	15.7	2.29	5.87		855	1.0
3/15/88	0.04	0.94	0.12	11.6	0.98	8.17		950	1.0
2/9/88	0.04	1.05	0.51	13.8	1.09	2.14		1115	1.0
1/12/88	0.24			14.5				1100	1.0

Date	NO2+NO3	TKN	TP	TOC	TN	N:P	N:P avg	Time	Depth
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			m
12/15/87	0.22			13.3				845	1.0
11/17/87	0.28			13.5				850	1.0
10/12/87	0.02			9.9				1010	1.0
9/15/87	0.32			8.7				845	1.0
8/11/87	0.11			8.6				840	1.0
7/14/87	0.37			8.9				940	1.0
6/9/87	0.20	1.26	0.33	8.4	1.46	4.42		812	1.0
5/12/87	0.50	1.68	0.26	11.8	2.18	8.38		800	1.0
4/14/87	0.56	4.76	0.80	20.2	5.32	6.65		810	1.0
3/10/87	0.20	1.19	0.23	10.0	1.39	6.04		830	1.0
2/16/87	0.21	3.04	0.30	12.2	3.25	10.83		1012	1.0
1/12/87	0.32	1.14	0.17	9.7	1.46	8.59		1000	1.0
12/9/86	0.14	4.40	0.40	12.4	4.54	11.35		815	1.0
11/18/86	0.11	1.34	0.37	11.7	1.45	3.92		830	1.0
10/14/86	0.03	1.61	0.33	11.4	1.64	4.97		810	1.0
9/9/86	0.27	1.09	0.26	7.7	1.36	5.23		735	1.0
8/12/86	0.25	0.98	0.25	11.8	1.23	4.92		801	1.0
7/15/86	0.34	0.60	0.17	7.5	0.94	5.53		810	1.0
6/10/86	0.33	1.32	0.29	13.0	1.65	5.69		805	1.0
5/13/86	0.93	1.49	0.39	18.3	2.42	6.21		815	1.0
4/15/86	1.14	3.87	0.74	24.3	5.01	6.77		735	1.0
3/18/86	0.46	2.21	0.36	19.2	2.67	7.42		730	1.0
2/18/86	0.34	1.37	0.28	13.1	1.71	6.11		748	1.0
1/14/86	0.19	1.09	0.19	11.0	1.28	6.74		1135	1.0
12/10/85	0.17	0.87	0.20	9.7	1.04	5.20		1100	1.0
11/19/85	0.11	1.03	0.24	12.0	1.14	4.75		1100	1.0
10/15/85	0.26	3.30	0.45	15.9	3.56	7.91		755	1.0
9/10/85	0.03	0.86	0.19	11.8	0.89	4.68		940	1.0
8/13/85	0.21	0.55	0.23	7.6	0.76	3.30		1142	1.0
7/8/85	0.52	0.92	0.21	9.1	1.44	6.86		1136	1.0
6/10/85	0.33	1.38	0.30	11.3	1.71	5.70		1230	1.0
5/13/85	0.72	1.30	0.38	13.7	2.02	5.32		1250	1.0
4/8/85	0.98	1.19	2.25	46.4	2.17	0.96		1230	1.0
3/11/85	0.26	1.28	0.34	14.3	1.54	4.53		945	1.0
2/12/85	0.17	0.80	0.18	11.5	0.97	5.39		1100	1.0
1/14/85	0.36	1.04	0.25	10.4	1.40	5.60		1212	1.0
12/10/84	0.02	0.92	0.15		0.94	6.27		1100	1.0
11/13/84	0.25	0.84	0.27		1.09	4.04		1250	1.0
10/8/84	0.35	1.47	0.33	11.9	1.82	5.52		910	1.0
9/10/84	0.33	1.20	0.33	11.0	1.53	4.64		1140	1.0
8/13/84	0.38	1.19	0.30	7.2	1.57	5.23		900	1.0
7/10/84	0.35	0.75	0.23	6.0	1.10	4.78		845	1.0
6/11/84	0.07	0.55	0.04	8.6	0.62	15.50		1100	1.0

Date	NO2+NO3	TKN	TP	TOC	TN	N:P	N:P avg	Time	Depth
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			m
5/13/84	0.78	1.54	0.38	15.0	2.32	6.11		1145	1.0
4/9/84	0.95	9.21	2.08	32.5	10.16	4.88		1218	1.0
3/12/84	0.31	1.37	0.22	11.2	1.68	7.64		1150	1.0
2/14/84	0.05	1.01	0.08	13.6	1.06	13.25		1130	1.0
1/10/84	0.37	2.05	0.42	13.8	2.42	5.76		1150	1.0
12/13/83	0.04	0.54	0.11	9.1	0.58	5.27		930	1.0
11/15/83	0.29	1.22	0.35	8.9	1.51	4.31		950	1.0
10/10/83	0.27	0.69	0.22	6.3	0.96	4.36		1215	1.0
9/13/83	0.30	1.10	0.24	6.6	1.40	5.83		1015	1.0
8/9/83	0.04	0.53	0.08	7.2	0.57	7.13		1045	1.0
7/12/83	0.27	0.85	0.27	7.4	1.12	4.15		1000	1.0
6/14/83	0.38	1.04	0.47	6.9	1.42	3.02		1010	1.0
5/10/83	0.94	2.23	0.47	11.0	3.17	6.74		945	1.0
4/12/83	0.09	0.95	0.13	7.2	1.04	8.00		1000	1.0
3/15/83	0.30	1.04	0.20	12.4	1.34	6.70		935	1.0
2/8/83	0.08	1.24	0.11	12.0	1.32	12.00		1000	1.0
1/11/83	0.06	0.86	0.21	11.0	0.92	4.38		1020	1.0
12/14/82	0.13	1.06	0.20	8.6	1.19	5.95		945	1.0
11/16/82	0.22	0.64	0.38	8.0	0.86	2.26		1030	1.0
10/12/82	0.33	1.13	0.35	10.4	1.46	4.17		1015	1.0
9/13/82	0.10	0.83	0.27	9.8	0.93	3.44		930	1.0
8/10/82	0.32	1.29	0.41	9.4	1.61	3.93		930	1.0
7/12/82	0.38	0.69	0.19		1.07	5.63		1030	1.0
6/15/82	0.24	1.10	0.21		1.34	6.38		1015	1.0
5/11/82	0.51	1.68	0.28	11.0	2.19	7.82		1040	1.0
4/13/82	1.05	2.25	1.45	57.5	3.30	2.28		945	1.0
3/9/82	0.28	1.70	0.19	13.4	1.98	10.42		1000	1.0
2/9/82	0.21	1.52	0.22	19.0	1.73	7.86		1015	1.0
12/15/81	1.18	3.05	0.95	17.9	4.23	4.45		1015	1.0
11/17/81	0.31	1.00	0.24		1.31	5.46		1045	1.0
10/13/81	0.16	1.35	0.29	10.5	1.51	5.21		1000	1.0
9/15/81	0.20	2.01	0.26	6.0	2.21	8.50		1000	1.0
8/11/81	0.23	0.93	0.23	7.5	1.16	5.04		1045	1.0
7/14/81	0.34	2.22	0.29	6.0	2.56	8.83		1000	1.0
6/9/81	0.17	1.34	0.20	10.5	1.51	7.55		950	1.0
5/12/81	0.45	2.08	0.31		2.53	8.16		1000	1.0
4/14/81	1.64	6.37	1.48	11.5	8.01	5.41		930	1.0
3/10/81	0.30	1.47	0.33	9.0	1.77	5.36		950	1.0
2/10/81	0.29	1.39	0.28	10.0	1.68	6.00		950	1.0
1/13/81	1.09	3.58	1.34	9.2	4.67	3.49		930	1.0
12/9/80	0.17	1.04	0.22	10.0	1.21	5.50		1030	1.0
11/18/80	0.25	1.18	0.36	8.5	1.43	3.97		1045	1.0
10/14/80	0.13	0.66	0.09		0.79	8.78		1005	1.0

Date	NO2+NO3	TKN	TP	TOC	TN	N:P	N:P avg	Time	Depth
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			m
9/16/80	0.12	0.71	0.18		0.83	4.61		945	1.0
8/12/80	0.25	1.05	0.19	5.0	1.30	6.84		945	1.0
6/10/80	0.52	1.14	0.21	5.8	1.66	7.90		1000	1.0
5/13/80	6.70	2.24	0.28	6.0	8.94	31.93		930	1.0
4/15/80	0.16	0.99	0.11	7.0	1.15	10.45		945	1.0
3/11/80	0.25	1.37	0.30	6.0	1.62	5.40		900	1.0
2/12/80	0.15	0.66	0.07	7.0	0.81	11.57		1000	1.0
1/15/80	0.11	0.80	0.12	13.0	0.91	7.58		945	1.0
12/10/79	0.16	2.84	0.35	13.5	3.00	8.57		1025	1.0
11/6/79	0.14	1.12	0.32	14.0	1.26	3.94		900	1.0
10/9/79	0.35	0.72	0.27	4.2	1.07	3.96		910	1.0
9/11/79	0.21			4.5				1125	1.0
8/14/79	0.27			3.0				1150	1.0
6/11/79	0.19	1.05	0.16		1.24	7.75		900	1.0
5/15/79	0.54	1.16	0.28	7.0	1.70	6.07		1112	1.0
4/17/79	0.38	1.75	0.50	12.5	2.13	4.26		1055	1.0
2/13/79	0.18	0.74	0.20	7.5	0.92	4.60		1130	1.0
1/9/79	0.62	0.81	0.08	16.0	1.43	17.88		1200	1.0
12/12/78	0.37	1.27	0.48	13.5	1.64	3.42		600	1.0
10/10/78	0.74	1.46	0.45	14.0	2.20	4.89		1230	1.0
9/12/78	0.14	1.11	0.29		1.25	4.31		1200	1.0
8/15/78								1300	1.0
7/11/78	0.28	1.29	0.26		1.57	6.04		0	1.0
6/13/78	0.52	1.30	0.60		1.82	3.03		1330	1.0
5/9/78	1.04	4.10	0.60		5.14	8.57		1200	1.0
4/11/78	0.73	.	1.27					1230	1.0
3/7/78	0.60	1.62	0.30		2.22	7.40		1126	1.0